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Related Art (56)

236,136(43,692/58)	81.2; 59.1.
130,689(739/46)	60.3; 59.1; 62.1.
163,714(18,325/53)	59.1; 59.2; 30.5.

The following statement is a full description of this invention, including the best method of performing it known to us:

19682/71—1 W. G. Murray, Government Printer, Canberra

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This invention relates to means for displacing objects using two or more tension load applying members. It is also directed to means for ensuring that the movements caused by the tension applying members bear a substantially constant ratio to each other.

The invention is particularly applicable to the lifting or tilting of concrete building floor slabs at a uniform rate.

The principal object of the present invention is to overcome substantially the disadvantages of existing equipment for the same purpose.

The invention in a general form is a load applying system comprising at least two antifriction nut and screw devices, means for anchoring the devices to anchorages and to an object to be moved and means for causing relative rotation of each screw and its associated nut so as to displace the object towards or away from the anchorages.

By "antifriction" is meant that the coefficient of friction between nut and screw varies from .1 to no higher than .25, in contrast to a conventional screw jack in which the coefficient is about .3.

Two preferred forms of the invention are illustrated in the accompanying drawings in which :-

FIGURE 1 is a perspective view of typical column and floor slabs showing jacking units of a first preferred form secured to each side of the column and supporting the floor slabs.

FIGURE 2 is an elevation in section on the line 2-2 in FIGURE 1,

FIGURE 3 is an enlarged fragmentary elevation in vertical section of a second preferred form of a jacking unit.

FIGURE 4 is a typical electric circuit associated with one form of the invention, and

FIGURE 5 is a plan of a typical column and slab arrangement.

The first form of jacking unit is shown in FIGURES 1 and 2. As can be seen two jacking units 5 are used secured to the respective sides of a typical column 6.

Each jacking unit 5 includes a heavy vertical base plate 7 which bears against the side of the column 6. A floor plate 8 extends horizontally and approximately medially from the base plate 7, and gear boxes 9 and 10 are provided on the upper and lower faces respectively of the plate 8.

A jacking motor unit 11 and a synchronising unit 12 are secured to the outer vertical face 13 of the gear box 10. Both units 11 and 12 are driveably interconnected by bevel gearing 14, to a primary lay shaft 15 rotatably mounted in bearings 16 medially mounted in each end 17 of the gear box 10. Normally 11 drives 12 through 14 and 15.

The plates 7 and 8 are stiffened by gusset plate webs 18, and a second lay shaft 19 is rotatably mounted in bearings secured to said webs 18, above the level of the gear box 9, and parallel to the shaft 15.

The lay shaft 19 is driveably connected to the shaft 15 by an external chain 20, and a second chain drive 21 conveys the drive to a third lay shaft 22 within the gear box 9. A worm 23, mounted on the shaft 22 within the gear box 9, engages a worm wheel 24 which is keyed to the upper end 25 of a screwed jacking shaft

26. A heavy circular nut 27, threadably engaged with the upper end 25 of the jacking shaft, and locked thereon by a key 28 and set screw 29, rests upon the hub 30 of the worm wheel 24, and said hub 30 in turn rests upon an angular contact roller thrust bearing 31 supported on the floor plate 8 of the jacking unit 5.

The jacking units 5 are secured to the column 6 in the following manner. A series of rectangular apertures 32 are formed in the opposed sides of the column 6 and a rectangular key bar 33 is located in a pair of said apertures 32 so that the bar projects horizontally from each side of the column 6. Rectangular apertures 34 are medially provided near the bottom of the base plate 7 of the jacking units 5, and the ends of the key bar 33 engage these apertures 34 when the jacking units are positioned against the column 6. The units 5 are then clamped against the column 6 by threaded pins 35 which are passed through holes (not visible) in the base plate 7, beyond the faces 36 of said column. The pins 35 are also passed through tubular sleeves 37 positioned between the opposed plates 7 of each jacking unit 5 to avoid undue bending stress on the said plates 7.

In the drawings the jacking units 5 are shown to be supporting, by way of example only, two concrete floor slabs 38. In this case the jacking shafts 26 extend downwardly through vertical cored holes 39 in the slabs 38, and are threadably engaged with ball nuts 40 below the slabs. The slabs 38 are adapted to rest upon a suitable system of plates 41 and rolled steel joists 42 which in turn rest on the upper face 43 of the ball nuts 40. Rotation of the jacking shafts 26 will cause the ball nuts 40 to ride up said jacking shafts and raise the slabs 38.

The jacking units 11 associated with the screws 26 are designed to operate in synchronism with one another with a high degree of mechanical accuracy.

Synchronism is obtained by one of two methods or both and the alternative methods are covered in this application.

In the case of a full electric system, i.e. where 11 is an electric motor, the jacking units 11 may have synchronising resistors 44 (see FIGURE 4) inserted in their rotor circuits 45 to provide an energising source for some or all the synchronising torque required for satisfactory operation and this is the first alternative method of providing synchronism.

In the embodiments shown in FIGURES 1, 2 and 3 where separate synchronising units 12 are used, these units 12 are positively connected to the main jacking units 11 by the bevel drive 14 and are driven at either super or subsynchronous speed from the jacking units 11. The synchronous units 12 have their stator windings 46 connected in parallel across the a.c. source of supply 47 and their rotors 48 are mutually connected in parallel as shown in FIGURE 4 of the drawing. The stator windings 49 and rotor windings 50 of the jacking motor units 11 are also connected to the a.c. source of supply 47 as shown in FIGURE 4. By this arrangement, if one of the jacking units 11 increases or decreases its rate of movement, e.g. due to varying load, the synchronising unit 12 will react to decrease or increase the said rate until all jack screws 26 are once again moving at the same rate. The principle of this invention is still valid should the stator and rotor connections 46, 48, 49 and 50 on either the jacking unit 11 or the synchronising unit 12 be interchanged.

In the commonest use of the invention, one or more concrete floor slabs 38 will require to be lifted from above, e.g. by two or more screw jacking units 5 supported on the already erected column 6 and joist frame of a multistorey building. The jacks will be arranged in spaced parallel sets with two or more spaced aligned jacks in each set. The screw of each jack will be secured to the slab.

For vertical lift with the slab 38 substantially horizontal, the intended displacement rate of all jacking units 5 will be the same, i.e. the displacement ratio will be 1:1 and the gear ratio setting of all units 5 will be the same.

If the slab 38 is to be tilted, again with parallel sets of spaced jacking units, the gear ratio setting of all units 5 in each set will be the same but the ratio will vary from set to set.

The lifting operation is carried out by the high efficiency screw 26 and nut 40, the application of which is subject of portion of this patent application. Such a screw and nut are described as a recirculating ball screw and nut. As this patent application and design are based primarily on the ball screw principle all following discussions will be based on this unit and alternative designs of load bearing screws will be subject to these patent applications.

In FIGURE 2 the screw 26 is rotated but is not displaced axially. Its rotation is converted into vertical displacement of 40 which in turn displaces the slab 38.

In FIGURE 3 the screw 26A is displaced axially and is connected directly at its lower end to the slab.

A similar recirculating ball screw and nut arrangement is used to displace 40 in FIGURE 2 as to displace 26A in FIGURE 3.

The ball nut used can be seen in greater detail in FIGURE 3 which illustrates a second form of jacking unit 5A in which the nut 51 is rotated about the jacking shaft 26A.

In this form the jacking unit 5A comprises plates 7A and 8A and gear boxes 9A and 10A as before. The nut 51 is secured to a worm wheel 24A in a medial cavity 52 within the worm wheel 24A, the hub 30A of which rests on a double thrust bearing 31A supported on the plate 8A of the jacking unit.

The helix 53 cut in the surface of the jacking shaft 26A is of semicircular cross-section and a similar helix 54 is cut within the bore of the nut 51. A series of balls 55 interengage the helices 53 and 54 of the nut and shaft and will be rolled upwardly or downwardly within the nut according to the direction in which it is rotated. The balls will therefore emerge at either the top or bottom of the nut and a bye pass passage 56 is provided within the body of the nut to return the balls 55, either to the top or bottom of the nut helix 54 according to its rotation.

In a further preferred form of the invention not illustrated in the drawings, each jacking unit is provided with a single reluctance electric motor in place of the twin units 11 and 12 used in the forms shown in the drawings.

These reluctance motors embody a conventional three phase stator and a salient pole rotor with no field winding. The rotor is built up from laminations in the usual fashion, but with longitudinal grooves cut in the periphery of said rotor into which are secured relatively wide copper bars. These copper bars act as wide "air gaps" so that the motor functions in a synchronous manner over a considerable portion of the lower range of its output.

The rotor of a conventional "squirrel cage" motor is readily adaptable to the configuration just described to provide the "reluctance" type motor required, and a jacking unit provided with this form of prime mover would be considerably less complicated and expensive to manufacture than the jacking units illustrated in the drawings.

For applications where the load is relatively light the system of lifting is covered by the principle of electrical operation below and is still subject to this patent application should conventional types of screw threads be employed.

For securing relative rotation, e.g. between 51 and 26A or 40 and 26, alternative low friction screws may be used, e.g. screws with antifriction inserts, e.g. of Teflon (Trade Mark), in the load bearing portion of the thread.

Although the units 11 are shown as electric motors other motors may be used, e.g. an internal combustion engine with a slipping clutch, a hydraulic drive or a pneumatic drive.

In such cases speed variations from normal in 11, which will be transmitted through 14 and 15 to 12,

will initiate control by 12 to restore the speed of 11 to normal.

Where 11 is not an electric motor the components 44, 45, 49, 50 can be eliminated from the circuit of FIGURE 4.

In FIGURE 5 is shown one possible column and slab arrangement with columns A, B, C and D and a slab 38.

As shown in FIGURES 1, 2 and 3 each column has secured to it two sets of components 11, 12 and 26. In FIGURE 5 only one set is used at each column to support the slab 38 and it is only necessary to synchronise the displacement caused by 11A, 12A, 26A with those caused by the sets attached to the other columns.

FIGURE 4 shows only the electrical components for two such column sets.

Another column and slab arrangement might be with a slab as outlined at 38E in which case each column might have two sets such as 11A, 12A, 26A, or even three or four such sets, coupled to the slab.

In all cases all units such as 11A are controlled by units such as 12A to maintain constant speed.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS :

1) A load applying system comprising at least two antifriction nut and screw devices, means for anchoring the devices to anchorages and to an object to be moved and means for causing relative rotation of each screw and its associated nut so as to displace the object towards or away from the anchorages. (23RD JUNE, 1965)

2) A system as in claim 1 wherein control means are provided for maintaining substantially constant the object-displacement achieved by each antifriction device. (23RD JUNE, 1965)

3) A slab lifting system for use in the construction of buildings having spaced columns, the system comprising lifting units, each adapted to be secured to a column and coupled to a slab to be lifted or lowered, each unit comprising a jacking screw, a nut, antifriction means coupling the screw and nut, means for causing relative rotation of the screw and nut and means for using such relative rotation to lift or lower the slab. (23RD JUNE, 1965)

4) A system as in claim 3 wherein control means are provided for maintaining substantially constant the movement of the slab by the nut and screw. (23RD JUNE, 1965)

5) A slab lifting system having at least two units, each comprising a support adapted to be secured to a column, a jacking screw rotatably mounted near its upper end on the support, a jacking motor on the support and coupled to the screw for rotating it and an antifriction nut engaging the screw near its lower end and adapted to be raised or lowered by rotation of the screw and to support a slab to be raised or lowered. (23RD JUNE, 1965)

6) A slab lifting system having at least two units, each comprising a support adapted to be secured to a column, a jacking screw, an antifriction nut rotatably mounted on the support in engagement with the screw and a jacking motor on the support and coupled to the nut for rotating it to displace the screw axially, the screw being secured near its lower end to the slab. (23RD JUNE, 1965)

7) A system as in claim 5 or 6 wherein control means are provided for maintaining substantially constant the movement of the slab by the nut and screw. (23RD JUNE, 1965)

8) A system as in claim 5, 6 or 7 wherein the nut and screw engagement is of the recirculating ball type. (23RD JUNE, 1965)

9) A system as in claim 7 wherein each jacking motor is an electric motor and the control means comprise synchronising resistors inserted in a circuit common to all jacking motor rotors. (23RD JUNE, 1965)

10) A system as in claim 7 including also for each jacking motor an electric synchronising unit driven by the motor, the control being effected by connecting the stator windings of all synchronising units in parallel across the A.C. supply and the rotor windings of all synchronising units in parallel across the A.C. supply. (23RD JUNE, 1965)

11) A system as in claim 7 wherein each jacking motor is an electric motor and control is achieved by making it a reluctance motor. (23RD JUNE, 1965)

12) A slab lifting system substantially as described in the specification and shown in FIGURES 1, 2 and 4 or FIGURES 3 and 4 of the drawings. (23RD JUNE, 1965)

DATED this THIRD day of JUNE, 1966
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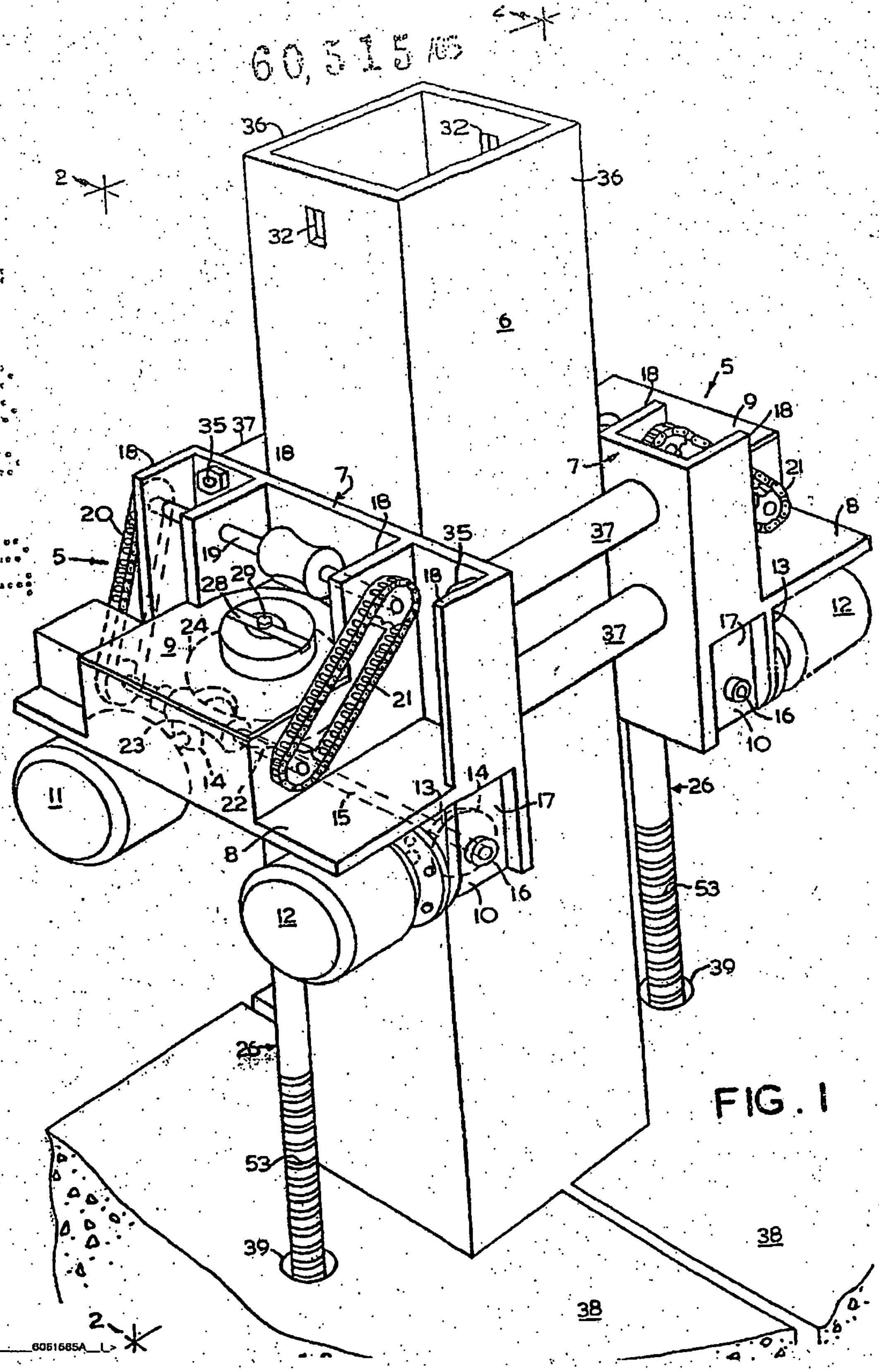

FIG. I

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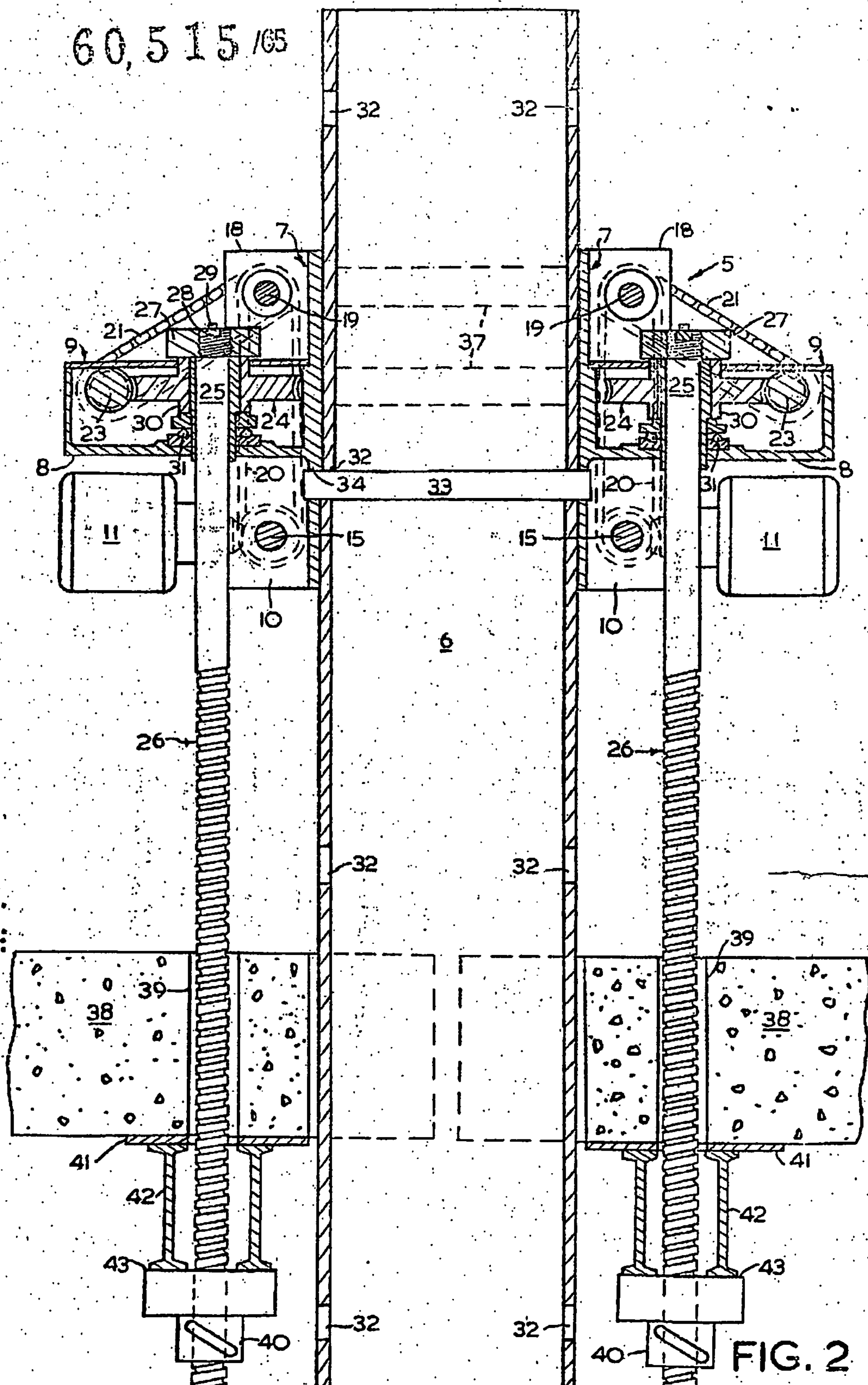

FIG. 2

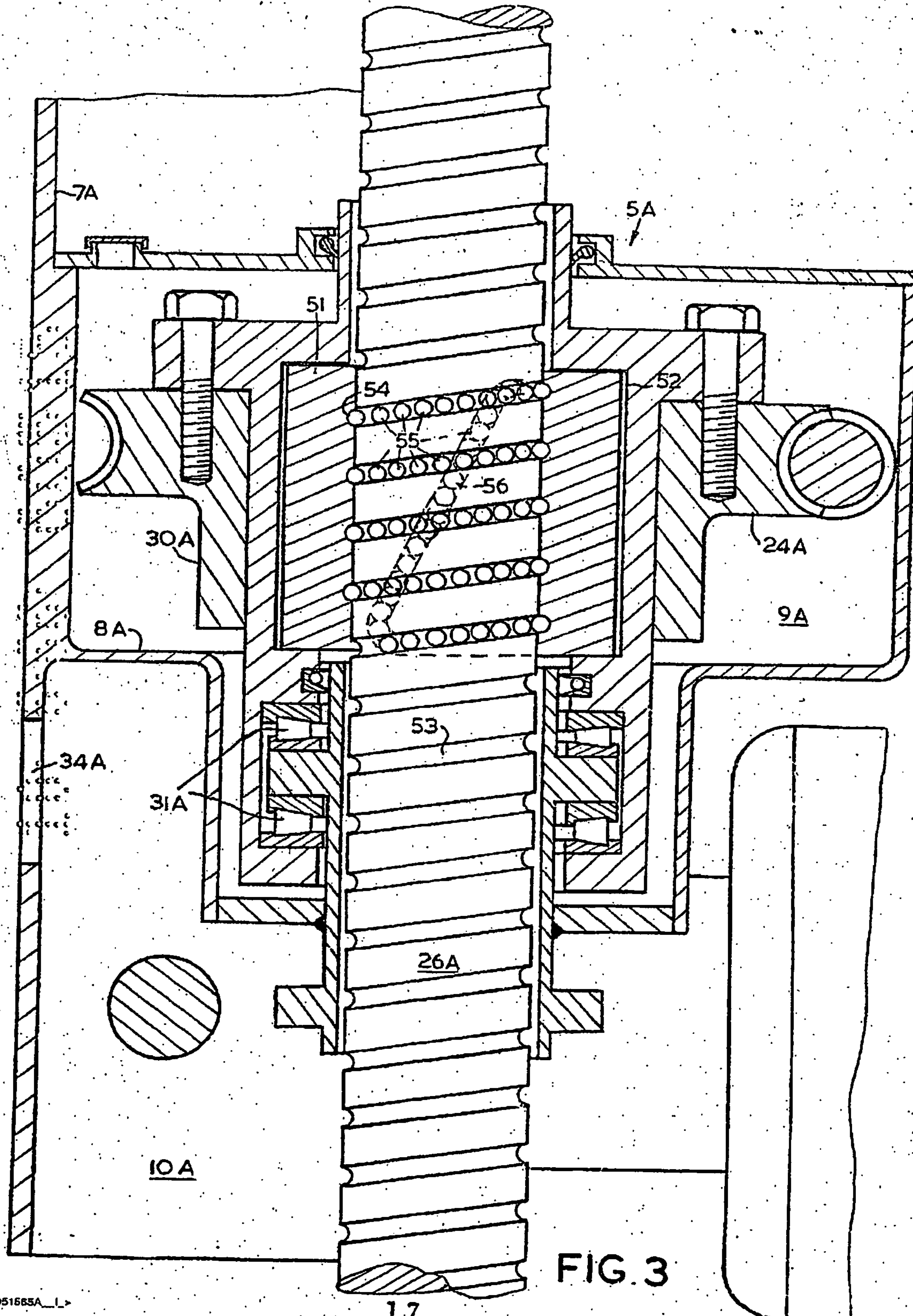

FIG. 3

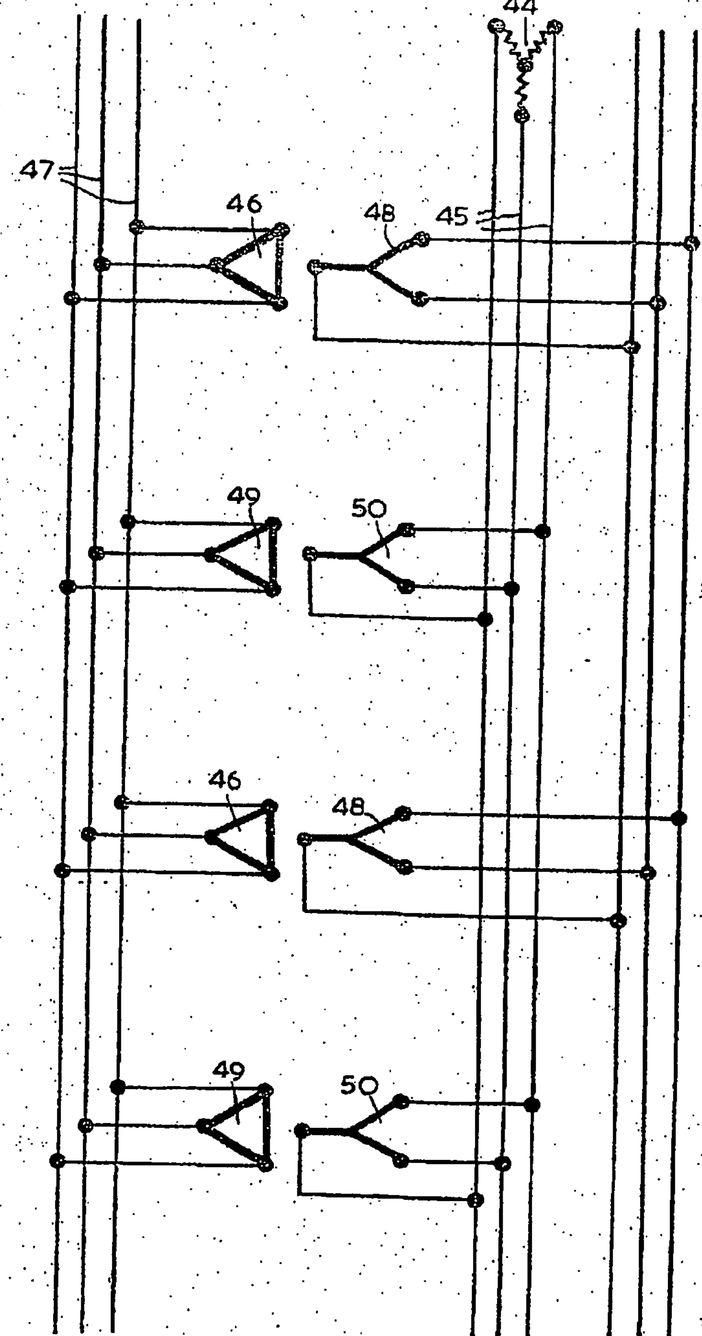

FIG. 4 19

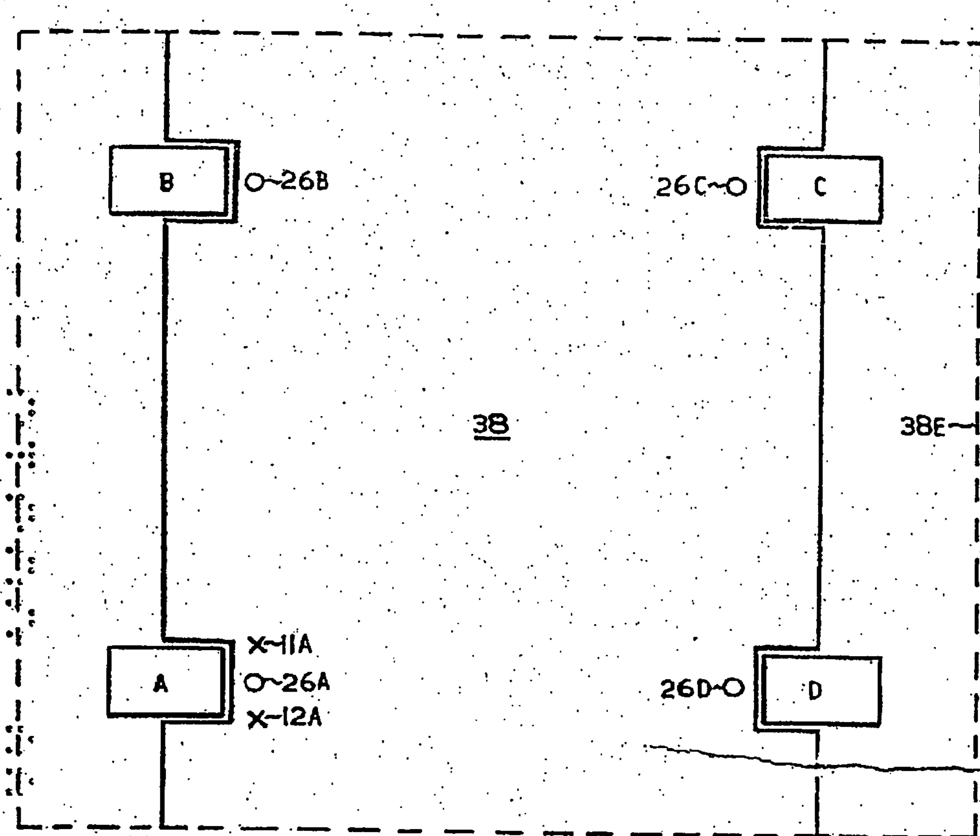

FIG.5